



# INSTITUTO DE BIOTECNOLOGIA VEGETAL

ANNUAL REPORT - 2018



Universidad  
Politécnica  
de Cartagena

Campus  
de Excelencia  
Internacional



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## FROM THE VICEPRESIDENT FOR RESEARCH

Since its creation, researchers belonging to IBV have focused their scientific work in areas such as environmental sciences, horticulture, technology and food sciences, water resources, agronomy, ... and agriculture in general.

All these areas are closely related to the Sustainable Development Goals, proposed by all the Member States of the United Nations in 2015, as strategic lines to achieve a better and more sustainable future for all. On the other hand, FAO proclaims "a world free of hunger and malnutrition, where food and agriculture contribute to improving the living standards of all, especially the poorest, in an economically, socially and environmentally sustainable way."

After 20 years of experience in research, training of doctors, leadership in European, national and regional projects, obtaining private financing, we know that the IBV team of researchers is prepared to address the global challenges we face, that will continue to develop its research lines to improve food security and nutrition and improvements in productivity and technological advances related to agriculture.



**Prof. Dr. Beatriz Miguel Hernández**

## FROM THE DIRECTOR

The Instituto de Biotecnología Vegetal has performed an intense work during the 2018 year in four main axes. The first one is via publication in scientific journals. Eleven out of the top 20 cited paper from the UPCT have been published by several units of the IBV, giving high visibility to our University. Furthermore, our scientific output in terms of number of publications has stayed at a high level throughout 2018. We are striving through collaborations to increase the quality of our work as the future of funding is linked to quality. A second aspect has been the acquisition of extramural funding. Currently we have five European projects, the last one started in 2018. While the current national funding is at a low level, the different units have been able to secure several national projects. The third component is the applied research and consulting performed via Catedras, contracts and projects with the private sector. Here again we have maintained a high level of funding with a total cash flow close to 700.000€.

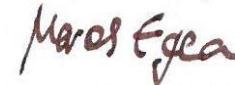
Finally, member of the IBV including technicians, students, researchers and faculty have taken part in transferring knowledge to the broad society through events organized by the UPCT such as the Proyecto Semilla Caritas, Semana de la Ciencia, Campus de la Ingeniería, Rutas Biotecnológicas and Rutas Agroalimentarias. Participation in events organized by third parties included seminars in high schools and short visits to the IBV.

Since 2017 we started to offer our infrastructure and pay for its use in order to obtain additional funding for maintenance and acquisition of small infrastructure. We have secured over 18000€ since the beginning of the policy implementation.

The IBV has maintained its activity as sponsor of teaching the Curso Internacional de Tecnología Postcosecha y Procesado Mínimo, the Online Course on Postharvest and Fresh Cut Technology. Researchers of the IBV teach at a Bayer-Crops master for their employees with the Universidad Politécnica de Valencia. Our teaching duties included the formation of technicians of the program "*Ayudas a la contratación en prácticas de titulados en Formación Profesional de Grado Superior*". This allowed us to form two persons in 2018.

Our current challenges continue to be the employment of sufficient technical personnel to tackle all the work we can perform but cannot due to lack of

dimension, and the acquisition of new infrastructure to maintain our research lines and develop new ones.



**Prof. Dr. Marcos Egea Gutiérrez Cortines**

**Director**

**Publications:**

<https://www.upct.es/ibvupct/publicaciones.php>

**Projects and R+D Contracts:**

<https://www.upct.es/ibvupct/proyectos.php>

**Patents:**

<http://www.upct.es/ibvupct/patentes.php>

## **COLLABORATIVE RESEARCH PROJECTS**

**Project title: DIVERFARMING: Crop diversification and low-input farming across europe: from practitioners engagement and ecosystems services to increased revenues and chain organization**

**Coordinator:** Dr. Raúl Zornoza (UPCT).



DIVERFARMING  
H2020 728003



With the long-term view of increasing diversification and biodiversity in Europe and fostering sustainable development of bioeconomy, the Diverfarming consortium has come together to develop and deploy innovative farming and agribusiness models. Diverfarming will increase the long-term resilience, sustainability and economic revenues of agriculture across the EU by assessing the real benefits and minimising the limitations of diversified cropping systems using low-input agricultural practices that are tailor-made to fit the unique characteristics of six EU pedoclimatic regions (Mediterranean South and North, Atlantic Central, Continental, Pannonic and Boreal) and by adapting and optimising the downstream value chains organization through executing 14 field case studies and 8 additional long-term experimental plots. This approach will provide: i) increased overall land productivity; ii) more rational use of farm land and farming inputs (water, energy, fertilisers...); iii) improved delivery of ecosystem services by increments in biodiversity and soil quality; iii) proper organization of downstream value chains adapted to the new systems with decreased use of energy; and iv) access to new markets and reduced economy risks by adoption of new products in time and space.

## Objectives:

**1. Development of new systems:** To develop and test different diversified cropping systems (rotations, multiple cropping and intercrops for food, feed and industrial products) under low-input practices, for conventional and organic systems to increase land productivity and crops quality.

**2. Benefits study:** to explore how the diversified cropping systems can, under low-input practices, increase the delivery of ecosystem services (soil fertility, prevention of soil and water contamination, water availability, reduced greenhouse gas (GHG) emissions, carbon sequestration, erosion prevention and pest and disease control).

**3. Impact evaluation:** to evaluate how the downstream value chains and the actors involved will be impacted by the new diversified cropping systems, and so, propose new organizational structures.

**4. Model development:** to develop and test agro-ecosystem models that will explore how the diversified cropping systems influence the land productivity and the soil-plant system.

**5. Systems evaluation:** to evaluate the proposed diversified cropping systems on the basis of their economic impact, at all levels. T.

**6. Communication and dissemination:** to communicate, disseminate and engage with European farmers, cooperatives, industry and logistics to develop, hone and embrace diversified cropping systems under low-input practices.

## Partners:



**Project title: SUPERPESTS: Innovative tools for rational control of the most difficult to manage pests ("super pests ") and the diseases they transmit**

**Coordinator:** Prof. Dr. John Vontas, Agricultural University of Athens.

**UPCT Coordinator:** Prof. Dr. Pablo Bielza.



The Research Unit "Resistance to insecticides" has started the European project "Innovative tools for rational control of the most difficult to manage pests ("super pests ") and the diseases they transmit. SUPERPESTS is funded by the Horizon 2020 Framework Program, whose main objective is to develop, evaluate and integrate a set of innovative products, tools and concepts with existing approaches, to achieve integrated and effective integrated pest management (IPM) of the "super pests", thus reducing the use of pesticides in the horticultural sectors. Data driven mathematical models will be used. The planned duration for the Project is 48 months.

#### **Objectives:**

- 1. Analyse pesticide resistance:** To develop diagnostic tools and biopesticide testing pipelines for the effective management of "super pest" resistance.
- 2. Characterise plant resistance elements:** To identify and characterise whitefly salivary effectors that affect host resistance in order to find novel bio-stimulants and/or targets for plant breeding.
- 3. Develop and test biopesticides:** To develop and evaluate green chemistry/bio-pesticide leads and products against the most resistant "super pests".

**4. Enhance performance of biological control:** Use selective breeding to produce key predators of crop pests that can be more readily integrated with other controls in IPM strategies designed for economically important vegetable and fruit crops.

**5. Communication and dissemination:** to promote integration of knowledge, dissemination, uptake to end-users and ensure sustainability of new tools and strategies.

As a global deliverable, the prediction and planning of the optimal use and combination of existing and novel specific control tools, with a particular emphasis on resistance evolution and its prevention will be obtained. This will enable a wide range of end-users and local policy makers to advice on optimal, site-specific control measures and pest intervention strategies.

#### **Partners:**



AGRICULTURAL  
UNIVERSITY OF  
ATHENS

**ENDURA**  
EXPLORING CHEMISTRY

GHENT  
UNIVERSITY

UNIVERSITY OF  
**EXETER**

University of Freiburg

**INRA**  
SCIENCE & IMPACT

bi-pa  
Biological Products for Agriculture

UNIVERSITY OF AMSTERDAM



**CSIC**  
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

Universidad  
Politécnica  
de Cartagena

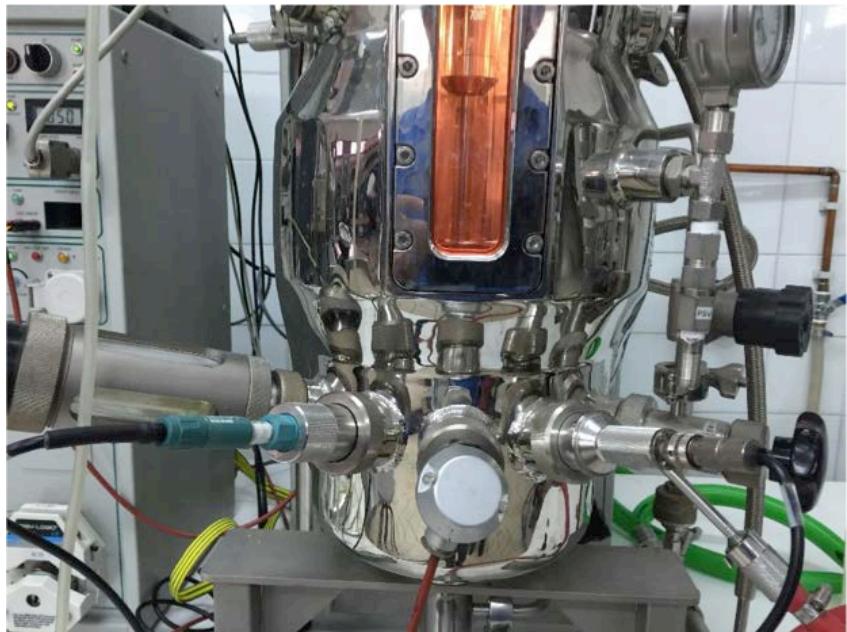
**biobest**  
SUSTAINABLE CROP MANAGEMENT

**Western**  
UNIVERSITY • CANADA

## **SPIN OFF companies**

## BIOENCAPSULATION AND iPACKAGING, S.L. (BIO-iPACK)

This spin off, created in June of 2017, is Located in Parque Tecnológico de Fuente Álamo (Murcia, Spain). It is dedicated to research, development, manufacture and commercialization of formulations of essential oils and their components, and micro and nanoencapsulates of these, and of other biomolecules and microorganisms, for the processing and active and intelligent packaging of food, pharmaceutical, cosmetic and veterinary products. This company is mainly focused on placing on the market products and technologies associated to patents developed by the Research Unit Biotechnological Processes, Technology and Engineering headed by Prof. Dr. Antonio López Gómez. One of these patent develops the concept of active cardboard packaging for fresh fruits and vegetables, in bulk or in flow-pack.



## **Private-funded CHAIRS**

## SUSTAINABLE AGRICULTURE



The Chair in Sustainable Agriculture of the UPCT is supported by the FECOAM and COAG associations, thirteen agriculture cooperatives of the Campo de Cartagena and the Fundación Bancaria "La Caixa".

### Main Results

The Region of Murcia financed a new line of research that will allow the evaporation of brines, obtaining solid salt and, consequently, a zero release to the Mar Menor. Currently, this process is in the final approval phase. With the support of the Chair of Sustainable Agriculture it will be of interest to all irrigators.

A technical report prepared by the General Office for Environment and Mar Menor concludes that the residual brines coming from desalting plants, as showed in an experimental project UPCT, does not require environmental processing. This document, in practice, validates the denitrification model developed through this research to eliminate nitrates from brines from water in aquifers.

**Director of the Chair:** Prof. Dr. Juan José Martínez Sánchez.



## **AWARDS**

The Fundación Coviran Award (2<sup>nd</sup> Ed.) for a food product or prototype made from plant-based foods with innovative methodology and that is not commercialized yet, was obtained by members of the Research Unit of Food Quality and Health and technical staff of IBV.

The award was for the development of a broccoli-based hummus rich in vitamins and bioactive compounds. The formula was optimized based on sensory quality evaluations by a trained panel at the Testing room of IBV and the product was manufactured at the IBV Pilot plant.

The award consisted on € 12,000 plus support and/or tutoring for the manufacture and/or marketing of the product.

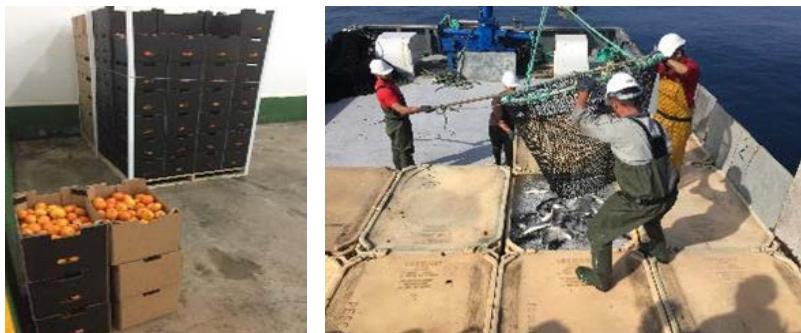
Responsible: Prof. Dr. Francisco Artés Hernández

Other members of the staff: Tâmmila Venze Klug, Ginés B. Martínez Hernández, Elena Collado, Francisco Artés Calero, Perla Gómez Di Marco and Noelia Castillejo Montoya. Granada, December 2018.



## **RESEARCH UNITS**

# BIOTECHNOLOGICAL PROCESSES, TECHNOLOGY AND ENGINEERING



## 1. Main results

In this year, 2 articles have been published in international journals (Frontiers in Microbiology; Horticulturae) with high impact factor in its fields. One patent has been published as US Patent and European Patent (also published as patent in Russia, Canada, and Mexico). In international congresses, 5 communications have been presented to AQUA2018 Int. Conference (organized by the World Aquaculture Society and European Aquaculture Society, Montpellier, France), and the IX Congreso Ibérico - VII Congreso Iberoamericano de Ciencias y Técnicas del Frío, CYTEF2018 (Valencia, Spain). Prof. Antonio López Gómez is Editor of the International Journal Food Engineering Reviews.

## 2. Projects (most relevant)

-Project title: New multi-active cardboard packaging solution to extend the shelf-life of fresh fruits and vegetables by 40% - Freshtray. Phase - 2, Call: H2020-SMEInst-2018-2020-2: (ref Agreement FRESHTRAY – 812001). Topic: SMEInst-02-2016-2017 — Accelerating the uptake of nanotechnologies advanced materials or advanced manufacturing and processing technologies by SMEs. Participants: UPCT and SAECO company (Molina de Segura, Murcia), Project Budget = 838.750,00 Euros (Grant = 587.125,00 Euros); from June 2018 to January 2020. Principal Investigator: Antonio López Gómez.

-Project title: “Innovative technology based on the integration of natural substances in ice to improve animal welfare and extend shelf-life of farmed fish” Phase - 2. Call H2020-SMEInst-2-2016-2017, in the area of SMEInst-08-2016-2017; Supporting SMEs efforts for the development - deployment and market

replication of innovative solutions for blue growth (ref Agreement ICE2LAST - 804493). Participants: UPCT and Univ. Murcia, and Pescados de Acuicultura de Murcia S.L., and CUBI-PLAYA S.L. (San Pedro del Pinatar, Murcia). Project Budget = 974.638,00 Euros (Grant = 682.246,00 Euros); from May 2018 to April 2020. Principal Investigator: Antonio López Gómez.

## 3. Selected publications

- Garre, A., Egea, J. A., Iguaz, A., Palop, A., Fernández, P. S. 2018. Relevance of the induced stress resistance when identifying the critical microorganism for microbial risk assessment. *Frontiers in Microbiol.*, 9, 1663.
- López-Gómez, A., Soto-Jover, S., Ros-Chumillas, M. 2018. New technology for enhancement the food safety of minimally processed fruits and vegetables. *Acta Hort.*, 1194 (2), 545-551.

## 4. Others: Most relevant contracts

- Contract title: Refrigerated meat products without gluten and healthier. Funded by CDTI - R&D Project 2017 (IDI- 20170705). Participants: UPCT and SEDIASA ALIMENTACIÓN S.A. Company (Madrid); from 01/04/2017 to 31/03/2020; Grant = 514.788,43 €; UPCT Contract: 150.000 €. Principal Researcher: Antonio López Gómez.
- Contract title: New technologies for decontamination and packaging of fresh culinary herbs. Funded by CDTI - R&D Project 2017 (IDI- 20170712). Participants: UPCT and AGROHERNI S.C.L. Company (Las Palas, Fuente Álamo, Murcia); from 01/05/2017 to 30/04/2019; Grant = 279.103,48 €; UPCT Contract: 105.500 €. Principal Investigator: Antonio López Gómez.

**Staff:** Head of the Unit: Prof. Dr. Antonio López Gómez. **Researchers:** Prof. Dr. Asunción Iguaz Gainza, Dr. Sonia Soto Jover, Dr. María Ros Chumillas, Dr. Domingo Miranzo Navarro, Dr. Vera Antolinos; M.Sc. and Ph.D. Students: M. José Sánchez Martínez, Laura Navarro Segura, Laura Buendía Moreno, Amanda E. López Cánovas.

# FOOD QUALITY AND HEALTH



## 1. Main results

- Supplementation with L-citrulline improves athletes' recovery after physical exercise of maximum intensity.
- The spirulina supplementation of a green smoothie ensured full coverage of the recommended vitamins.
- Development of healthy snack from fruits and vegetables by-products (melon and watermelon).
- Innovative ethylene scavenging systems to extend fruit/vegetable shelf life.

## 2. Projects (most relevant)

-Implantación de técnicas ecoinnovadoras para la mejora de la producción, calidad y comercialización de una nueva variedad de melón. RIS3. Principal investigador: Encarna Aguayo.

-Dispositivo electrónico comercial para la medición de vitamina C en la industria alimentaria (e-DiVITA). Principal investigador: Encarna Aguayo y Antonio. J. García Sánchez.

-Avances en sensorización y análisis multivariable aplicados a refrigeración industrial agroalimentaria: técnicas de data-mining para identificación de nuevas correlaciones y mejora de la eficiencia energética. RIS3. Principal investigators: Ángel Molina y Francisco Artés-Hernández.

## 3. Selected publications

Álvarez-Hernández M.H., Artés-Hernández F., (...), Martínez-Hernández G.B. 2018. Current scenario of adsorbent materials used in ethylene scavenging systems to extend fruit and vegetable postharvest life. *Food Bioprocess Technol.*, 11: 511-525.

Castillejo, N., Martínez-Hernández, G.B., Lozano-Guerrero, A.J., Pedreño-Molina, J.L., Gómez, P., Aguayo, E., Artés, F., Artés-Hernández, F. 2018. Microwave heating modelling of a green smoothie. Effects on glucoraphanin,

sulforaphane and S-methyl cysteine sulphoxide changes during storage. *J. Sci. Food Agric.*, 98(5), 1863-1872.

Esteras, C., Rambla, J.L., Sánchez, G., López-Gresa, M.P. González-Mas, M.C., Fernández-Trujillo, J.P., Bellés, J.M., Granell, A., Picó, M.B., 2018. Fruit flesh volatile and carotenoid profile analysis within the *Cucumis melo L.* species reveals unexploited variability for future genetic breeding, *J. Sci. Food Agric.*, 98, 3915-3925.

Falagán, N., Artés, F., Aguayo, E., 2018. Heat treatment as postharvest tool for improving quality in extra-early nectarines. *J. Sci. Food Agric.*, 98(4), 1469-1475.

Venzke-Klug, T., Collado, E., Martínez-Sánchez, A., Gómez, P.A., Aguayo, E., Otón, M., Artés, F., Artés-Hernández, F. 2018. Innovative quality improvement by continuous microwave processing of a faba beans pesto sauce. *Food Bioprocess Technol.*, 11, 3, 561-571.

## 4. Others: Ph.D. Dissertations

- Funcionalidad de un zumo de sandía enriquecido en L-citrulina: valoración de sus efectos in vivo en deportistas. Author: Bárbara Fernández. Supervisors: Encarna Aguayo, Ascensión Martínez.

-Innovative development and processing of vegetables-based formulations: purees, juices, sauces and hummus. Author: Tâmmila Venzke Klug. Supervisors: Francisco Artés-Hernández y Francisco Artés.

## 5. Awards:

- Isaac Peral y Caballero in recognition for the scientific production during 2018.
- Fundación Coviran Award (2<sup>a</sup> Edition): Award for a food product or prototype made from plant-based foods with innovative methodology..

**Staff:** Head of the Unit: Prof. Dr. Encarna Aguayo. **Researchers:** Prof. Dr. Francisco Artés-Hernández, Prof. Dr. Juan P. Fernández-Trujillo, Prof. Dr. Francisco Artés-Calero, Dr. Ascensión Martínez-Sánchez, Dr. Ginés B. Martínez-Hernández, Dr. Bárbara Fernández-Lobato. **M.Sc. and Ph.D. Students:** Noelia Castillejo, Elena Collado, Tâmmila Venzke-Klug, Hazel Álvarez.

## GENETIC RESOURCES



### 1. Main results

During 2018, the Unit have continued working on the conservation, characterization and evaluation of genetic resources, mainly in the framework of one Project financed by the Ministerio para la Transición Ecológica of the Spanish Government. Also, we have carried out the annual collection of indigenous wild plant material and their conservation in the Germplasm Bank-UPCT.

We have also achieved a project (*Retos Sociedad 2017*), which will allow to deepen in the induction of resistance in plants grown in floating system.

### 2. Projects (most relevant)

-Uso de composts supresivos y sus extractos biológicos en la producción sostenible y de calidad de rúcula y lechuga *baby leaf* en suelo y en bandeja. MINECO (AGL2014-52732-C2-2). Participants: UPCT, CEBAS-CSIC. Principal investigator: J.A. Pascual, J.A. Fernández at UPCT. January 2015- June 2018.

-Validación de compost como inductores de propiedades funcionales y de resistencia frente a patógenos para la producción sostenible de hortalizas de hoja pequeña. MINECO (AGL2017-84085-C3-3-R). Participants: UPCT, CEBAS-CSIC, UMH. Principal investigator: J.A. Pascual, C. Egea-Gilabert at UPCT. 2018 – 2021.

-Acciones para la recuperación y conservación de la especie en peligro de extinción jara de Cartagena (*Cistus heterophyllus* subsp. *carthaginensis*). Fundación Biodiversidad del Ministerio para la Transición Ecológica. 2017-2018. Principal investigator: María José Vicente Colomer.

### 3. Selected publications

Atila, F., Tuzel Y., Fernández, J. A.; Faz Cano, A., Sen, F. 2018. The effect of some agro-industrial wastes on yield, nutritional characteristics and antioxidant activities of *Hericium erinaceus* isolates. *Sci. Hortic.* 238: 246-254.

Bodner, G., Kronberga, A., Lepse, L., Olle, M., Vägen, I. M., Rabante, L., Fernández, J.A., Ntatsi, G., Balliu, A., Rewald, B. 2018. Trait identification of faba bean ideotypes for Northern European environments. *Eur. J. Agron.* 96: 1-12. <https://doi.org/10.1016/j.eja.2018.02.008>

Fernández, J.A., Orsini, F., Baeza, E., Oztekin, G.B., Muñoz, P., Contreras, J., Montero, J.I. 2018. Current trends in protected cultivation in Mediterranean climates. *Eur. J. Hortic. Sci.* 83: 294-305.

Karkanis, A., Ntatsi, G., Lepse, L., Fernández, J.A., Vägen, I.M.; Rewald, B., Alsina, I., Kronberga, A., Balliu, A., Olle, M., Bodner, G., Dubova, L., Rosa, E., Savvas, D. 2018. Faba bean cultivation – revealing novel managing practices for more sustainable and competitive European cropping systems. *Front. Plant Sci.* 9:1115..

Martínez-Díaz, E., Martínez-Sánchez, J.J., Conesa, E., Franco, J.A., Bañón, S., Vicente, M.J. 2018. Germination and morpho-phenological traits of *Allium melananthum*, a rare species from south-eastern Spain. *Flora* 249: 16-23. <https://doi.org/10.1016/j.flora.2018.09.005>

**Staff:** Head of the Unit: Prof. Dr. María José Vicente Colomer. **Researchers:** Prof. Dr. Sebastián Bañón, Prof. Dr. Encarnación Conesa, Prof. Dr. Catalina Egea-Gilabert, Prof. Dr. Juan Esteva Pascual, Prof. Dr. José A. Franco Leemhuis, Prof. Dr. Juan A. Fernández, Prof. Dr. Juan J. Martínez Sánchez, Prof. Dr. Jesús Ochoa. M.Sc. and Ph.D. Students: Almudena Giménez Martinez.

# MICROBIOLOGY AND FOOD SAFETY



## 1. Main results

The Unit received financial support during 2018 from two research projects and has lead one national network, all of them funded by the Spanish Government, and from two contracts with a pharmaceutical company and The German Federal Institute for Risk Assessment (BfR). Members of this Unit also participate in a spin-off company, recently created. Four articles were published in indexed journals. One Ph. D. Dissertation was also presented in this period.

## 2. Projects (most relevant)

-Validation of mild heat preservation processes of foods: establishing microbial food safety. MINECO (AGL 2013/48993-C2-1-R). 2014-2018. Principal investigator: Fernández, Pablo, Principal co-investigator: Palop, A..

-Validation of new tools and processes for analysis and improvement of microbial food safety. MINECO (ref AGL2017-86840-C2-1-R). 2018-2020. Principal investigator: Alfredo Palop, Principal co-invest.: Pablo Fernández.

-Development of the structure needed to carry out a quantitative biological risk prioritization and assessment in Spain. MINECO (Ref. AGL 2016-82014-REDT). 2017-2019. Principal investigator: Pablo S. Fernández.

## 3. Selected publications

Garre, A., Huertas, J.P., González-Tejedor, G., Fernández, P.S., Egea, J.A., Palop, A. and Esnoz, A. 2018. Mathematical quantification of the induced stress resistance of microbial populations during non-isothermal stresses. *Int. J. Food Microbiol.*, 266: 133-141.

Garre, A., Egea, J.A., Iguaz, A., Palop, A. and Fernández, P.S., 2018. Relevance of the induced stress resistance when identifying the critical microorganism for microbial risk assessment. *Frontiers in Microbiol.*, 9: 1663.

Garre A., Clemente-Carazo M., Fernández P.S., Lindqvist R., Egea J.A. 2018. Bioinactivation FE: A free web application for modelling isothermal and dynamic microbial inactivation. *Food Res. Internat.*, 112: 353 - 360.

Garre A., González Tejedor G., Peñalver Soto J.L., Fernández P.S., Egea J.A. Optimal characterization of thermal microbial inactivation simulating nonisothermal processes. *Food Res. Internat.*, 107: 267 - 274.

## 4. Others:

**Ph. D. Dissertation:** Mathematical modelling for the microbiological risk assessment of food following mild preservation treatments. Author: Alberto Garre. Supervisors: Pablo S. Fernández and José A. Egea. **Extraordinary Ph. D. Award.**

**Contract: References:** 5224/18IAEA and 5325/18IAEA. Company: BBraun Medical S.A. Contract leader: Alfredo Palop; Contract, company: The German Federal Institute for Risk Assessment (BfR). Contract leader: Pablo S. Fernández.

**Spin-off Company:** Bioencapsulation and iPackaging, S.L. Fuente Álamo.

**Staff:** Head of the Unit: Prof. Dr. Alfredo Palop. Researchers: Prof. Dr. Pablo S. Fernández, Prof. Dr. Paula M. Periago. Ph.D. and Master Students: Alberto Garre, Mariem Sormrani, Marta Clemente.

## MOLECULAR GENETICS



### 1. Research interest and main results

Our research concentrates on the elucidation of genetic programs related to the circadian clock and environmental factors controlling different aspects of plant development, including growth, flowering time, flower number and volatile production. Characterization of clock gene mutants includes the usage of computer vision and machine learning (ML) algorithms for automatic phenotype data analysis. The development of bioinformatic applications for automated analysis of GC-MS data of volatiles forms part of the investigation as well as the generation and analysis of sequencing data of microbial communities form a variety of biological samples.

### 2. Projects (most relevant)

- Fundación Séneca, 19398/PI/14. Determinación del control de la emisión de volátiles florales por el bucle nocturno del reloj circadiano en petunia.
- Diverfarming H2020- 2017-2022.
- CDTI- Artificial vision and plant development-2017-2019.

-MELOMUR-RIS3 2018-2022.

-BFU-2017 88300-C2-1-R. Análisis de genes de control del desarrollo floral y la emisión de volátiles. Desarrollo de fenotipado automático mediante visión artificial basado en máquinas de aprendizaje.

### 3. Selected publications

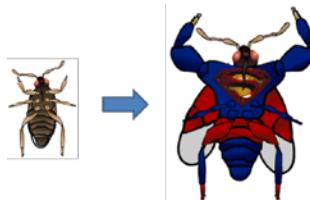
- Ruiz-Hernández, V., Roca, M. J.; Egea-Cortines M., Weiss, J. 2018. A comparison of semi-quantitative methods suitable for establishing volatile profiles. *Plant Methods*. 14:67.
- Egea-Cortines, M., Doonan, J. 2018. Phenomics. *Frontiers in Plant Sci.*
- Weiss, J., Terry, M. I., Martos-Fuentes, M., Letourneux, L., Ruiz-Hernández, V., Fernández, J. A., Egea-Cortines, M. 2018. Diel pattern of circadian clock and storage protein gene expression in leaves and during seed filling in cowpea (*Vigna unguiculata*). *BMC Plant Biology*, 18: 33-53.

### 4. Others

**Ph.D. Dissertation:** Genetic structure of scent profiles in *Antirrhinum*. Implications for the evolution and interaction with pests and pollinators. Author: M. Victoria Ruiz Hernández. Supervisors: Marcos Egea Gutiérrez-Cortines and Julia Weiss.

**Staff:** Head of the Unit: Prof. Dr. Julia Weiss. Researchers: Prof. Dr. Marcos Egea Gutiérrez-Cortines. M.Sc. and Ph.D. Students: Victoria Ruiz-Hernández, Raquel Alcantud-Rodríguez, Claudio Brandoli, Fernando Pérez-Sanz, Marta I. Terry, María Victoria Díaz-Galián, Semih Arbatlı, Onurçan Özbollat.

## RESISTANCE TO INSECTICIDES



### 1. Main results

The *de novo* sequencing of the genome of *Trioza erytreae* was finalized, and we are in the annotation process. Resistance of neonicotinoids in *Myzus persicae* and to diamides in *Tuta absoluta* were detected for the first time in Spain. Several strains of *O. laevigatus* were obtained by selective breeding with enhanced cold tolerance, bigger body size, better response to non-prey feeding, and higher resistance to a number of insecticides, such as pyrethroids, natural pyrethrins, spinosad, and neonocotinoids..

Biotechnological tools based on *Tomato Leaf Curl New Delhi Virus* (ToLCNDV) were developed. An infectious clone of ToLCNDV and several replicons based on the virus sequence were established. One of the designed replicons may allow sequence specific mutations at a high frequency in *Solanaceae* and *Cucurbitaceae*.

### 2. Projects (most relevant)

-Mejora genética del agente de control biológico *Orius laevigatus*: potencial biótico y resistencia a insecticidas. AGL2017-89600-R. MINECO. 2018-2020. 80.000 €. Euros. Principal investigator: Pablo Bielza.

-Innovative tools for rational control of the most difficult-to-manage pests ("super pests") and the diseases they transmit. SUPERPESTS. 773902. Horizon 2020 Framework Programme. 2018-2022. Total 2.991.525 €, UPCT: 240.000 €. Principal investigator: Pablo Bielza.

-Gestión integrada de *Trioza erytreae*: resistencia a insecticidas, control biológico, muestreo y susceptibilidad varietal. E-RTA2015-00005-C06-06. INIA. 2017-2020. 150.000 €. Principal investigator: Pablo Bielza.

-Uso sostenible de insecticidas en *Myzus persicae*: diseño de una estrategia de manejo de la resistencia. AGL2014-55298-R. MINECO. 2015-2018. 110.000 €. Principal investigator: Pablo Bielza.

-Resistencia a insecticidas en *Myzus persicae*: mecanismos implicados y estrategias de manejo. 19282/PI/14. Fundación Séneca. 2015-2018. 25.740 €. Principal investigator: Pablo Bielza.

-Desarrollo de herramientas biotecnológicas basadas en el virus emergente *Tomato leaf curl New Delhi virus*. Fundación Séneca. 1925/PI/2014. Participants: IBV-UPCT, CEBAS-CSIC, AbioPep S.L. 2015-2018. 66.000 €. Principal investigator: César Petri.

### 3. Selected publications

Moreno, I., Belando, A., Grávalos, C., Bielza, P. 2018. Baseline susceptibility of Mediterranean strains of *Trialeurodes vaporariorum* (Westwood) to cyantraniliprole. Pest Management Sci., 74: 1552-1557.

Roditakis, E., Vasakis, E., García-Vidal, L., Martínez-Aguirre, M., Rison, J., Haxaire-Lutun, M., Nauen, R., Tsagkarakou, A., Bielza, P. 2018. A four-year survey on insecticide resistance and likelihood of chemical control failure for tomato leaf miner *Tuta absoluta* in the European/Asian region. J. Pest Sci., 91: 421-435.

### 4. Others: Ph. D. Dissertations

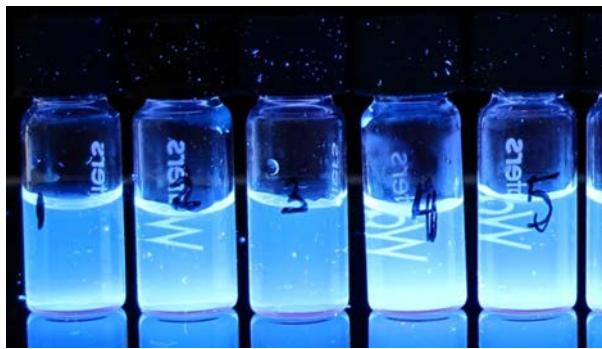
-Resistencia a diamidas, spinosad e indoxacarb en *Tuta absoluta* (Meyrick) (*Lepidoptera: Gelechiidae*). Author: Lidia García Vidal. UPCT. Supervisor: Pablo Bielza.

-Resistencia a nuevos insecticidas en moscas blancas de hortícolas. Author: Inmaculada Moreno Vicente. Supervisor: Pablo Bielza.

**Awards:** Premio "Isaac Peral y Caballero" (Modalidad B), for the activity during 2017.

**Staff:** Head of the Unit: Prof. Dr. Pablo Bielza. Researchers: Prof. Dr. Josefina Contreras, Prof. Dr. Dina Cifuentes, Prof. Dr. Juan A. Martínez López, Dr. César Petri, Dr. Carolina Grávalos. M.Sc. and Ph.D. Students: María A. Parra, Lidia Martín, Virginia Balanza, María Martínez, José E. Mendoza, Inmaculada Moreno.

## SECONDARY METABOLITES



### 1. Main results

Seedlings derived from metalloous populations of plants grown on mine tailings piles responded more promptly and efficiently to chronic heavy metal stress under controlled conditions than those derived from non-metalloous populations. The former not only had higher constitutive concentrations of antioxidant metabolites, but also were able to limit translocation of Pb to shoots. Within a plant, the response to high concentrations of heavy metal differed between roots and shoots, the former showing increased concentrations of S-based antioxidants.

### 2. Projects (most relevant)

-Functional analysis of antioxidant and redox systems in the abiotic stress tolerance of cultivated plants: new perspectives for their agronomical applications and their potential human health benefits. Fundación Séneca (19876/GERM/15). 2016-2020. Project manager: Francisca Sevilla (CSIC).  
-Elicitación acústica de resistencia sistémica en plantas. MICINN (AGL2017-92217-EXP). 2018-2020. Principal investigator: Antonio Calderón.

### 3. Selected publications

Ferrer, M.A., Cimini, S., López-Orenes, A., Calderón, A.A., De Gara, L. 2018. Differential Pb tolerance in metalloous and non- metalloous *Zygophyllum fabago* populations involves the strengthening of the antioxidative pathways. Environ. Experim. Botany 150: 141-151.

López-Orenes, A., Bueso, M.C., Párraga-Aguado, I., Calderón, A.A., Ferrer, M.A. 2018. Coordinated role of soluble and cell wall bound phenols is a key feature of the metabolic adjustment in a mining woody fleabane (*Dittrichia viscosa* L.) population under semi-arid conditions. Sci. Total Environ., 618: 1139-1151.

López-Orenes, A., Bueso, M.C., Conesa, H.M., Calderón, A.A., Ferrer, M.A. 2018. Seasonal ionomic and metabolic changes in Aleppo pines growing on mine tailings under Mediterranean semi-arid climate. Sci. Total Environ., 637-638: 625-635.

López-Orenes, A., Dias, M.C., Ferrer, M.A., Calderón, A.A., Moutinho-Pereira, J., Correira, C., Santos, C. 2018. Different mechanisms of the metalliferous *Zygophyllum fabago* shoots and roots to cope with Pb toxicity. Environ. Sci. Pollution Research 25: 1319-1330.

Ribeiro-Lucho, S., Nogueira do Amaral, M., Milech, C., Ferrer, M.A., Calderón, A.A., João Bianchi, V., Bolacel Braga, E.J. 2018. Elicitor-induced transcriptional changes of genes of the steviol glycosides biosynthesis pathway in *Stevia rebaudiana* Bertoni. J. Plant Growth Regul., 37: 971-985.

Sánchez-Sánchez, J., López-Orenes, A., Ferrer, M.A., Calderón, A.A. 2018. Subtle changes in light intensity affect in vitro responses but not ex vitro performance of *Limonium sinuatum*. 3 Biotech, 8: 335.

### 4. Others: Ph. D. Dissertations.

-Expression patterns of antioxidant network in pioneer plants from mine tailings polluted with high levels of heavy metals (Ph.D. Thesis with International Mention and recognised with a UPCT Extraordinary Doctoral Award). Author: Antonio López Orenes. Supervisors: M. Ángeles Ferrer and Antonio A. Calderón.

-Estudio y optimización del proceso de propagación in vitro de *Limonium sinuatum*. Author: Jesús Sánchez Sánchez. Supervisor: Antonio A. Calderón

**Staff:** **Head of the Unit:** Prof. Dr. Antonio A. Calderón. **Researchers:** Prof. Dr. M. Ángeles Ferrer, Dr. Matías López Serrano, B.Sc. Antonio López Orenes.

## SOIL ECOLOGY AND BIOTECHNOLOGY



Core sediment from bottom of the Mar Menor lagoon.

Experimental plots in climate chamber.

Melon and cowpea in intercropped system.

Phytostabilization plots on a tailings pond.

### 1. Main results

-A complete biogeochemical characterization of the bottom sediments from the Mar Menor lagoon is in progress (<http://suelos.upct.es/es/node/172>), to evaluate the trophic state and pollution in the sediments and its influence in the quality of the water column.

-The role of microbiology in the biogeochemical cycles at mining impacted soils is under study. Several scenarios are tested as those without external inputs (non-amended) and with the addition of soil amendments (e.g. biochar, compost). In addition, the effects of plants and litter in the self sustaining support of the functional attributes at each scenario are evaluated (<http://suelos.upct.es/es/node/168>; <http://suelos.upct.es/es/node/99>).

-Within Diverfarming project (<http://www.diverfarming.eu/index.php/en/>) and AsociaHortus project (<https://www.facebook.com/AsociaHortus/>), DNA of soil samples from agricultural field case studies in Spain (vegetables, almonds, mandarins), Italy (cereals) and the Netherlands (vegetables) has been extracted and bacterial 16S region has been sequenced. Bacterial biodiversity was highly variable and it was not directly related to land and crop management.

-Within the Soil Take Care project (<http://soiltakecare.eu>), an experiment of phytostabilization has been initiated on a tailings pond with introduction of *Piptatherum miliaceum* and *Coronilla juncea*, with addition of different amendments, decreasing metal(lloid)s mobility and improving soil fertility.

### 2. Projects (most relevant)

-Biogeochemical study of the sediments from the Mar Menor lagoon bottom. 2018-2019. UPCT-IEO-USC-UCA. Principal investigator: José Álvarez Rogel.

-Functionality and resilience of soils polluted by mining wastes under climate change conditons in mediterranean environments: ecotoxicological aspects and the use biochar for remediation (CGL2016-80981-R). MINECO. 2017-2019. Principal investigator: José Álvarez Rogel.

-Sustainability for the phytomanagement of mining polluted soil: an ecophysiological and microbiological approach (CGL2017-82264-R). MINECO. 2018-2020. Principal investigator: Héctor Conesa.

-Crop diversification and low-input farming across Europe: from practitioners' engagement and ecosystems services to increased revenues and value chain organisation – Diverfarming. GA 728003. H2020. Europ. Comm. 2017-22. 10.457.923€ (UPCT: 1.3 M€). Principal investigator: Raúl Zornoza.

-Soil Take Care. SOE1/P4/F0023. Interreg-Sudoe. European Commission. 2016-2019. 2.009.646€ (UPCT: 349.200€). Principal investigator: Ángel Faz.

### 3. Selected publications

Álvarez-Rogel, J., Tercero, MC, Conesa, H., Párraga-Aguado, I., González-Alcaraz, MN. 2018. Biochar from sewage sludge and pruning trees reduced porewater Cd, Pb and Zn concentrations in acidic, but not basic, mine soils under hydric conditions. *J. Environ. Manag.*, 223: 554–565. ISSN: 0269-7491.

Martínez-Oró, D., Párraga-Aguado, I., Querejeta, J.I., Álvarez-Rogel, J., Conesa, H.M. 2019. Nutrient limitation determines the suitability of a municipal organic waste for phytomanaging metal(lloid) enriched mine tailings with a pine-grass co-culture. *Chemosphere*. 214: 436-444.

Sánchez-Navarro, V., Zornoza, R., Faz, A., Fernández, J.A. 2018. Comparing legumes for use in multiple cropping to enhance soil organic carbon, soil fertility, aggregates stability and vegetables yields under semiarid conditions. *Sci. Hort.*, 246: 835 - 841.

Soriano-Disla, J.M., Calupiña-Moya, R.D., Martínez-Martínez, S., Zornoza, R., Faz, A., Acosta, J.A. 2018. Evaluation of the performance of chemical extractants to mobilise metals for remediation of contaminated samples. *J. Geochem. Explor.* 193: 22 – 31.

**Staff:** **Head of the Unit:** Prof. Dr. José Álvarez. **Researchers:** Dr. Héctor Conesa, Prof. Dr. Ángel Faz, Dr. Raúl Zornoza, Dr. Martín Soriano. **M.Sc. and Ph.D. Students:** Obdulia Martínez, Nicolas Beriot, Onurçan Özbollat, Antonio Peñalver, Yolanda Risueño, Virginia Sánchez-Navarro.

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